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Spontaneous plastic deformation of irradiated metallic glasses

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ABSTRACT

Using large-scale molecular dynamics simulations, we predict that knock-on damage in irradiated metallic glasses leads to spontaneous anisotropic deformation, i.e., shape change in the absence of externally applied loads. The root cause of this behavior is anisotropic plastic deformation around nonspherical thermal spikes. Thermal spikes are nanoscale regions whose temperature briefly rises to several thousand K, causing rapid localized melting and quenching. Thermal spike-induced plasticity (TSIP) does not depend on electronic excitations and is distinct from the ion hammer effect. Macroscale TSIP is predicted to occur under unidirectional heavy ion and neutron irradiation. The consequences of TSIP for potential applications of metallic glasses under irradiation will be discussed.